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288 644

UNITED STATES ARMY ARMOR BOARD
Fort Knox, Kentucky

STEBB-ST P-2205

19 NOV 1962

SUBJECT: Report of Project No 2205, Evaluation of LVDS 1100 After-Cooled Engine

TO:

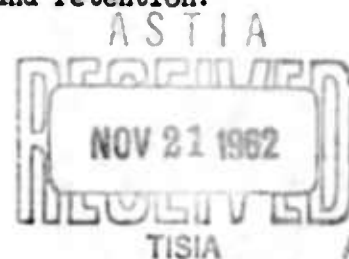
Commandant, United States Army Armor School, Fort Knox,
Kentucky
Director, USMC Landing Force Development Center, c/o USMC Liaison
Officer, US Army Armor Board, Fort Knox, Kentucky
British Liaison Officer, USATEC, c/o Director of Munitions, British
Embassy, 3100 Massachusetts Avenue, N. W., Washington, D. C.
Canadian Liaison Officer, US Army Materiel Command, Washington
25, D. C.
Commander, Armed Services Technical Information Agency, ATTN:
TIPCR, Arlington Hall Station, Arlington 12, Virginia

The subject report and copy of Headquarters, US Army Test and Evaluation
Command action letter is furnished for your information and retention.

FOR THE PRESIDENT:

L. F. Carney

L. F. CARNEY
Lt Col, CE
Secretary



AMSTE-BB

7 NOV 1962

SUBJECT: Report of Project No 2205, Evaluation of **LVDS 1100 After-Cooled Engine**

TO: Commanding General
U. S. Army Weapons Command
Rock Island Arsenal, Illinois

1. Reference Report of Project No 2205, Evaluation of **LVDS Engine 1100 After-Cooled Engine**, 31 October 1962, U. S. Army Armor Board (Incl 1).

2. This headquarters concurs in the conclusion in **paragraph 6** and the recommendation in **paragraph 7** of referenced report.

3. It is recommended that development of the **LVDS 1100 After-Cooled Engine** be continued and that test be conducted to determine durability and performance in a vehicle weighing **approximately 43 tons**.

FOR THE COMMANDER:

1 Incl
as

JOHN W. RODGERS
Colonel GS
C, Admin Div

Copy furnished w/o incl:
Pres, U. S. Army Armor Board

Incl 1

UNITED STATES ARMY ARMOR BOARD
Fort Knox, Kentucky

STEBB-CV P-2205

31 OCT 1962

SUBJECT: Report of Project No 2205, Evaluation of LVDS 1100
After-Cooled Engine

TO: Commanding General
United States Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland



1. AUTHORITY.

a. Directive.

(1) TWX, ATDEV-2 705318, HQ USCONARC,
29 Mar 62.

(2) FONECON between Lt Col A. J. Boller,
HQ USCONARC, and Captain Charles A. Roper, USAARMBD,
23 Jul 62.

b. Purpose. To determine the suitability of the LVDS
1100 after-cooled engine for use in future combat vehicles under
desert conditions.

2. DESCRIPTION OF MATERIEL.

a. The LVDS 1100 after-cooled engine is a 4-stroke
cycle, liquid cooled, turbo-charged, 90-degree, V8 cylinder, com-
pression-ignition engine with precombustion chambers. It has a
bore and stroke of 5.4 and 6.5 inches, respectively; piston displace-
ment of 1,191 cubic inches; and compression ratio of 17.5:1. It is
rated at 575 net horsepower at 2,200 rpm. Dry weight of the engine
alone is 2,485 pounds. (See inclosure 1 and 2 for photographs of the
engine.)

b. The primary difference between the preceding model of the LVDS 1100 engine and this modified version is the incorporation of an after-cooler. This device consists of a water-jacketed heat exchanger located just past the turbocharger compressor outlets. The compressed induction air is cooled before entering the intake ports resulting in greater air density and increased horsepower. At the cost of only 50 pounds additional weight, the engine net output is increased by 75 horsepower.

c. The test engine was coupled to an XTG-411 transmission and mounted in a T95 chassis. The vehicle was up-weighted to 76,800 pounds. Cooling was accomplished by the same cooling system used for the lesser powered version of the LVDS 1100 engine.

3. BACKGROUND.

a. Pursuant to the Department of the Army's engine policy, both air-cooled and liquid-cooled compression ignition engines with comparable characteristics suitable for installation and test in the T95 tank were developed. The desired characteristics were defined as lightweight, high performance, little maintenance, and developing approximately 550 net horsepower on diesel and Compression Ignition Engine fuel.

b. Development of an air-cooled engine of approximately 500 horsepower had previously been authorized. Concept studies for the design of a water-cooled engine were requested and several proposals were submitted in October 1957. In January 1958, Caterpillar Tractor Company's proposal (the LVDS 1100 engine) was selected.

c. Although development of the T95 tank was discontinued, the program for development and competitive testing of the liquid and air-cooled engines was continued for use in some future vehicle. A review meeting in December 1961 revealed that the air-cooled engine remained deficient in a number of ways and that additional time and funding would be required before it would be ready for test. As a result, US Army Tank-Automotive Command (ATAC) recommended and received approval for discontinuing further funding of the program. The Caterpillar LVDS 1100 engine was then placed under tank component development funding.

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After-Cooled Engine

d. By early 1962, the requirement (paragraph b above) was increased to 575 net horsepower for use in a vehicle weighing between 38 and 42 tons. An LVDS 1100 engine was up powered to 575 net horsepower, installed in a T95 tank, and furnished Ordnance Test Activity, Yuma Test Station, for evaluation in August 1962. As a result of known limitations in the T95 test bed installation, ATAC (OTAC) asked for Armor Board representation in the test in order to achieve the fullest evaluation of the engine in the shortest possible period of time.

e. The directive referenced in paragraph 1a(1) called for the Armor Board to observe the engineer test of the engine in the desert. This role was changed to active participation by the telephone call referenced in paragraph 1a(2).

4. SUMMARY OF TESTS. Test were conducted by Captain Wallace C. Steiger, Jr., Armor, assisted by personnel of the Ordnance Test Activity, Yuma Desert Test Station, Yuma, Arizona.

a. Preoperational Inspection. An initial technical inspection of the test item was conducted by the Combat Vehicle Shop of the Ordnance Test Activity at Yuma Test Station. Among the faults noted were the power package not being properly secured on its mounts and the compressor blades of the turbocharger damaged by apparent ingestion of foreign matter. A complete report on the initial inspection will be included in the Ordnance Test Activity first memorandum report on the LVDS 1100 after-cooled engine.

b. Engine Performance. The test item was operated for a total of 153 miles over all types of terrain available at the Yuma Test Station. Included were level, relatively hard-surface desert, level soft sand, moderate hills and gulleys, steep hills, and a hard-surface dynamometer course. Ambient temperatures varied from 97°F to 113°F. The manner of operation included maximum speed runs across each type of terrain and other movements of a more tactical nature involving rapid acceleration and movement around obstacles from one covered position to another.

(1) The engine easily pushed the test bed vehicle to its maximum governed speed of 37 miles per hour on all types of reasonably level terrain. Top speed could be maintained indefinitely without apparent effect on the engine. No overheating occurred although the cooling system being used was designed for an engine of lesser horsepower.

(2) Acceleration characteristics were excellent. Tests to determine the time to move from 0 to 30 mph on the dynamometer course, which was slightly inclined, yielded the following average results:

(a) Uphill - 27.9 sec

(b) Downhill - 23.6 sec

(3) The power delivered by the engine provided a high degree of agility and maneuverability. It is to be noted, however, that a fair amount of driver skill is required to extract maximum performance from this power package because of the necessity for shifting up and down through four forward speeds in order to keep the engine output at peak torque. This is in contrast to an engine with CD 850 type transmission where the driver has only to operate the accelerator and brake and occasionally shift in and out of low range. The test engine incorporates a device called a rack limiter which can severely delay acceleration unless the transmission is geared down to lowest level allowed by vehicle speed. The rack limiter reduces the amount of fuel injected into the cylinders upon depression of the accelerator pedal as a means of reducing exhaust smoke. The limiter can be adjusted to provide any desired trade-off between acceleration and exhaust smoke. The test engine was adjusted so that the smoke density on acceleration appeared to be about midway between an AVDS 1790-2 and a -2A engine. Acceleration at this setting was excellent when the tank was properly driven.

c. Fuel and Oil Consumption.

(1) Fuel economy was measured over the entire 153 miles of test operation during which the test engine was continually operating at peak output over all types of desert terrain. Results of the fuel consumption tests are as follows:

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Total mileage	153 miles
Total fuel (C.I.E.) consumed	230.5 gallons
Average fuel consumption	.664 mpg 1.51 gpm
Idle fuel consumption	1.2 gallons/hr

(2) An analysis of engine oil consumption was not possible due to a severe oil leak resulting from a cracked turbo-charger oil return line.

d. Security.

(1) The test engine, as installed in the T95 facility vehicle, was extremely noisy. The high pitched whine of the cooling fan could be detected over a mile away when the listener was downwind, and slightly less than a mile away under windless conditions. Engineers from Caterpillar, Ford, and Ordnance Test Activity agreed that when the engine was production engineered for a specific vehicle it would have 2 fans instead of 1, thereby reducing the rotating speed necessary to move a given quantity of air. With a reduction in fan speed would come a reduction in noise level.

(2) An accurate evaluation of the exhaust smoke output of the LVDS 1100 engine was not possible because of the extreme dust conditions in the desert. On the average, however, there appeared to be less exhaust smoke than that produced by a standard M60 tank with an AVDS 1790-2 engine.

e. Maintenance.

(1) An accurate evaluation of the ease with which organizational maintenance could be accomplished on this engine was not possible for two reasons. First, the basic engine was facility mounted on a T95 test bed with a cooling system considerably different from that which will ultimately be used. The location and consequently the accessibility of accessory items such as the generator, fuel and oil filters, and

crank case breather will change when the engine is production engineered for a specific vehicle. The second reason was that this was a prototype engine which had several developmental modifications added without being properly engineered to accept them in the most efficient manner. For example, installation of the after-cooler in the V of the engine restricts access to the fuel injector pump and connecting points for the accelerator and start - run control cables. When the engine is production engineered this interference can be reduced.

(2) Considering the test engine in its present configuration, it was found that all second echelon tasks could be performed with equal or greater facility than that required to perform corresponding tasks on current standard engines. Power package removal is greatly simplified by the three-point suspension of the engine and transmission and by the use of flexible control cables rather than linkages. Diagnosis and repair of trouble is aided by the absence of the extensive shrouding characteristics of air-cooled engines. Electrical quick disconnects are centralized in one readily accessible location. Also, the engine has a clean appearance being uncluttered by numerous oil lines and wiring harnesses.

(3) The preliminary maintenance package furnished with the test engine was actually intended for use with the earlier model AVDS 1100 engine of 500 net horsepower. It was, however, an excellent group of manuals containing well written, accurate, and concise explanations of maintenance procedures supplemented by an abundance of appropriate demonstrative photographs.

5. DISCUSSION.

a. The original requirement as stated in paragraph 3d was for a 575 net horsepower engine to be used in a vehicle weighing between 38 and 42 tons. The original test directive received by this board (paragraph 1a(1)) called for the engine to be operated in a test bed weighted to 43 tons.

b. The scope of this evaluation was, at the request of ATAC, limited to an evaluation of engine performance in 38-1/2 ton test bed. No attempt was made to determine durability and reliability or performance in a heavier vehicle.


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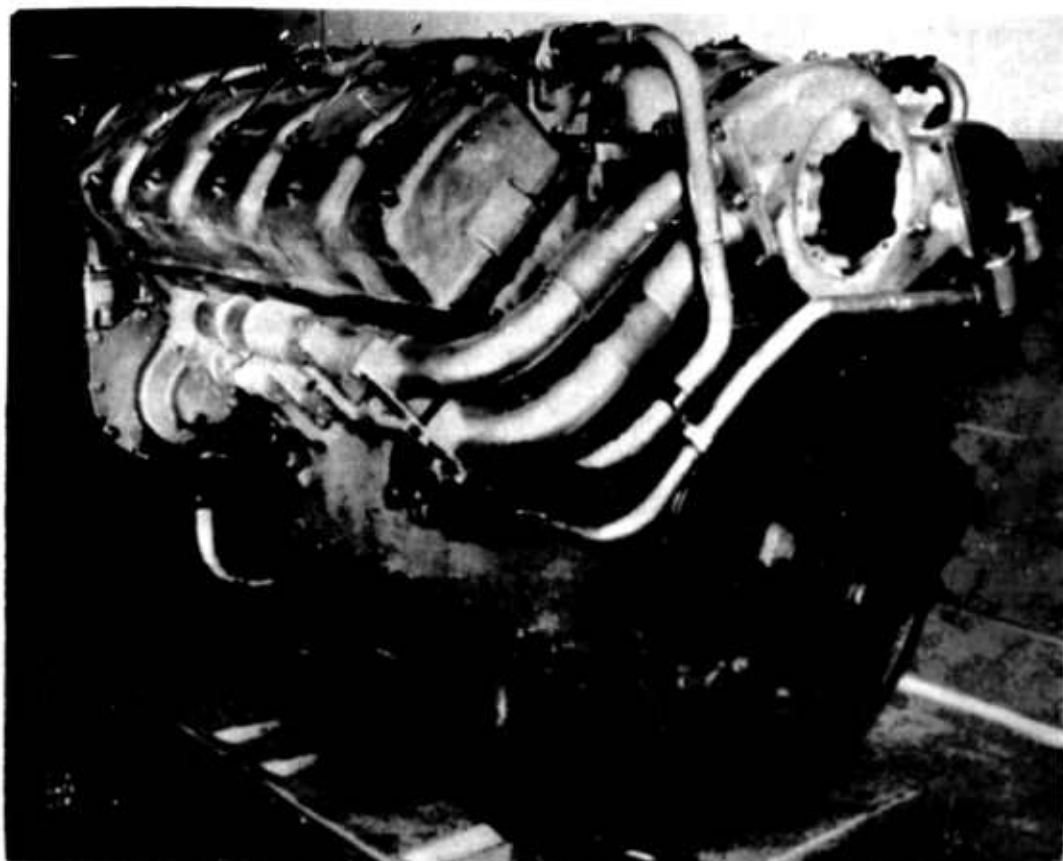
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After-Cooled Engine

6. CONCLUSION. The US Army Armor Board concludes that, with regard to performance and maintainability, the LVDS 1100 after-cooled engine will be suitable for use under desert conditions in future combat vehicles of approximately 38-1/2 tons weight after production engineering is accomplished.

7. RECOMMENDATION. The US Army Armor Board recommends that development of the LVDS 1100 after-cooled engine be continued and that tests be conducted to determine durability and performance in a vehicle weighing approximately 43 tons.

2 Incl
as


FRANK F. CARR
Colonel, Armor
President

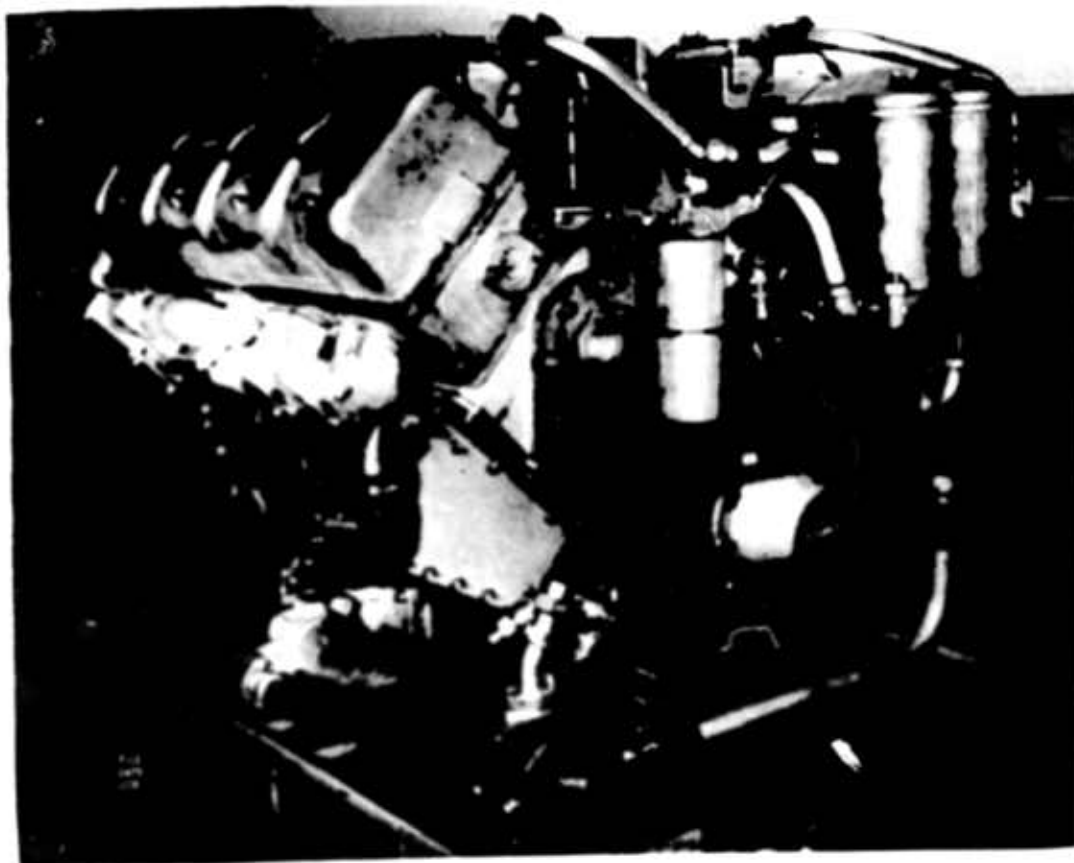


UNITED STATES ARMY ARMOR BOARD P-2205 PHOTO NO 62-1588 FT KNOX, KY

LVDS 1100 ENGINE

FLYWHEEL END OF THE ENGINE

Incl 1



UNITED STATES ARMY ARMOR BOARD P-2205	PHOTO NO. 62-1588A	FT KNOX, KY
LVDS 1100 ENGINE		
ACCESSORY END OF THE ENGINE		

Incl 2